APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE OF INVENTION

Title:	METHOD FOR AUTOMATICALLY CONTROLLING THE QUALITY OF CIGARETTES PRODUCED IN A MANUFACTURING PROCESS
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CROSS-REFERENCE TO RELATED APPLICATIONS

Not applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

REFERENCE TO A MICROFICHE APPENDIX

Not applicable.

BACKGROUND OF THE INVENTION

This invention relates to a method for automatically controlling the quality of cigarettes produced in a manufacturing processing.

In particular, the invention relates to a method for automatically controlling the quality of cigarettes produced in a manufacturing process by periodically extracting a sample of filter sections from a plurality of filter sections to be used to manufacture such cigarettes, testing the sampled filter sections to determine the value of certain specified quality parameters, and computing certain statistical values for the quality parameters of the sample of filter sections; by periodically extracting a sample of completed cigarettes from a plurality of finished cigarettes, testing the selected cigarettes to determine the value of certain specified quality parameters which are related to the quality parameters of the filter segments which have been measured, and computing certain statistical values for the sample of cigarettes being produced, and; by

adjusting the operational controls of the cigarette making machinery in the manufacturing process according to a pre-established algorithm to correct for any undesirable variance between the statistical values of the quality parameters computed from the filter segments sampled and the statistical values of the related quality parameters computed from the completed cigarettes sampled and by repeating this process to ensure the quality of cigarettes being manufactured.

The traditional cigarette includes both a rod-shaped tobacco component and a rod-shaped filter component which is affixed to one end of the tobacco component. Customarily rod-shaped filter sections twice the length of the filter component desired in a completed cigarette are prepared in a filter making machine in advance of the manufacture of the cigarettes. Because the manufacturing process for such filter sections includes a curing period after the filter sections are formed, the filter sections are not immediately provided to a cigarette-making machine. Further, some manufacturers obtain filter sections from suppliers or prepare them in locations remote to the cigarette making facility.

By contrast, the tobacco component is typically formed immediately prior to the time when it is joined with filter component into a completed cigarette. A tobacco rod is prepared in a tobacco rod-forming machine by forming and compressing cut filler tobacco into a cylindrical shape and wrapping the formed and compressed tobacco in paper. The paper is wrapped around the outer circumference of the formed and compressed tobacco and is glued in place. The tobacco rod is then cut into rod segments twice as long as the desired length of the tobacco component of a completed cigarette.

In the typical manufacturing facility the tobacco segments are immediately provided to a tipping machine in order to manufacture completed cigarettes. Pre-constructed filter sections are also fed to the tipping machine.

In the tipping machine the tobacco segment is cut at its midpoint, creating a first and a second tobacco component. The tipping unit separates the first and second tobacco components and inserts a filter section between them. A filter section is affixed to the first and second tobacco components by wrapping the filter section and a small portion of the first and second tobacco components adjacent to each end of the filter section with filter tip paper. The filter tip paper is glued to the filter section and to a small portion of the first and second tobacco components. The filter section is cut at its mid-point so that two cigarettes are formed, each of which comprises a filter component joined to a tobacco component.

Ensuring an adequate, non-leaking bond between the tobacco component and the filter component is critical to the manufacturing process. One typical and recurring reason for failure of the bond is that the circumference of a tobacco component varies significantly from the circumference of the filter component with which it is matched. Thus, one quality parameter for the manufacturing process is the circumference of the filter section. A related quality parameter is the circumference of the tobacco rod. When the variance between these two related quality parameters is minimal, the likelihood of producing acceptable quality cigarettes from the filter section and the tobacco segments is maximized.

Filter sections are manufactured so that the circumference of the filter sections falls within a specified tolerance range. Nevertheless, a sub-population of filter sections, particularly one from a population of filter sections provided to a cigarette manufacturer from a third-party source, may have a mean circumference substantially lower or substantially higher than the mid-point of the tolerance range. In such circumstances, if the cigarette manufacturer prepares tobacco segments with a circumference at the mid-point of the tolerance range it is possible that a substantial number of unacceptable cigarettes may be prepared.

Similarly, the weight of the tobacco content of each completed cigarette is an important quality parameter in manufacturing. The weight of the tobacco is related to burn duration and consequently impacts consumer perception of the quality of the cigarette. In most manufacturing applications, completed cigarettes are automatically sampled at predetermined intervals to determine the weight of the completed product. Sampling tobacco rods which have not yet been joined with filter sections or filter components is performed infrequently and usually only by manual sampling. This is because the rods are open at each end and tobacco can be lost from one or both ends during sampling. This results in inaccurate measurements.

Accordingly, an accurate measurement for the weight of the tobacco component is best achieved by measuring the weight of completed cigarettes and deducting from that value the weight of the filter component of the completed product. The filter sections used in cigarette production are manufactured so that the weight of the filter sections falls within a specified tolerance range. Nevertheless, a sub-population of filter sections may have a mean weight substantially lower or substantially higher than the mid-point of the tolerance range. In such circumstances and because the weight of the tobacco component is determined from completed cigarettes, cigarettes may be manufactured with inadequate or excess tobacco in the tobacco component.

Tobacco material is the major cost in cigarette production. It would be preferable, therefore, for the manufacturer to have a method to closely monitor the weight of filter sections from which cigarettes are being produced so that the weight of the tobacco component can be more accurately determined and adjusted in order to ensure quality and reduce tobacco waste.

The cost of producing unacceptable cigarettes is also substantial. The tobacco from rejected cigarettes is reclaimed for future use, but the filter and paper cannot be recycled.

Therefore, only 30% to 50% of the value of a rejected completed cigarette is recovered. Under current manufacturing practices, filter fall-off and leakage causes the rejection of as many as 0.5% of the completed cigarettes manufactured.

Additionally, cigarette-manufacturing machinery typically runs at relatively high rates of production. Single rod cigarette makers may produce up to 10,000 cigarettes per minute. Double rod cigarette makers may produce as many as 14,000 cigarettes per minute. Thus, large quantities of completed cigarettes are produced in relatively short periods of time. When variances from the expected manufacturing tolerances for filter components or tobacco components are encountered, a large amount of unsatisfactory product can be produced in a short amount of time.

Some of the machines used in the manufacturing process provide measuring equipment in the production line that provides continuous data regarding selected parameters of the product or component being produced. For example, most tobacco rod-forming machinery provides measuring equipment that continuously measures the weight or the density of the tobacco segments being produced. Such measuring equipment can help operators anticipate and avoid manufacturing tolerance errors. It is not uncommon, however, for these measuring devices to become inaccurate during production runs and to require recalibration. For example, it is not unusual for "slippage" to occur in nucleonic devices used to measure the weight or the density of tobacco rod segments during manufacture.

Additionally, both automatic and manual sampling and testing is accomplished during most production runs in order to determine whether completed product or components meet pre-established parameters. In many applications such sampling and testing is done infrequently and at irregular intervals. For example, in many manufacturing environments completed cigarette

products are sampled and tested hourly to determine the weight of the cigarette, the weight of the tobacco portion of the cigarette, the circumference of the tobacco component at its midpoint, and the filter ventilation of the cigarette. Most often such testing and sampling does not provide sufficient or timely data to permit adjustment of the operational controls of the manufacturing equipment to avoid variances from the manufacturing tolerances for the finished cigarette products or the cigarette components.

There is therefore a need for a manufacturing control method which reduces the variance between the circumference of the filter component and the circumference of the tobacco component by continuously adjusting the operational controls of the tobacco rod-forming machine such that the circumference of the tobacco component included in a manufactured cigarette is matched as closely as possible with the circumference of the filter section used to manufacture the cigarette and so that the value of other desired parameters for the completed cigarettes remains in the acceptable range.

There is also a need for a manufacturing control method which reduces the variance in the weight of the tobacco component by adjusting the operational controls of the tobacco rod-forming machine such that the weight of the tobacco segments remains optimal and is not varied by reason of the varied weights of the filter sections from the sub-population of filter sections being used in the manufacturing process.

There is further a need for a manufacturing control method which gathers data from completed product and from manufactured components on a sufficiently frequent and regular basis to allow for the continuous adjustment of the operational controls of the tobacco rod-forming machine such that the circumference of the tobacco segment being produced is matched as closely as possible with the circumference of the filter segment to be used with it in the

manufacturing process and so that the value of other desired parameters for the completed cigarettes remains in the acceptable range

Additionally, there is a need for a manufacturing control method which allows for the periodic dynamic calibration of measuring equipment in the production line to ensure that variances from manufacturing tolerances can be anticipated and corrected before they contribute to the creation of unsatisfactory completed products.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a method for the automatic control of the quality of cigarettes manufactured in a manufacturing process by gathering, in real time, data from measurements of samples of completed cigarettes and from samples of the filter sections used in the manufacture of such cigarettes and by using such data, according to a pre-established algorithm, to adjust the operational controls of one or more machines in the cigarette manufacturing process.

More specifically, the present invention provides a method for automatically controlling the quality of cigarettes manufactured by sampling and testing the filter sections used to manufacture the completed cigarettes and the completed cigarettes at frequent and regular intervals during the manufacturing process. The data generated by measuring specified quality parameters for filter sections and related quality parameters for the completed cigarettes are evaluated by a computer according to pre-established algorithm. The computer, according to the algorithm determines whether the data indicates that an adjustment in the operational controls controlling the manufacture of the tobacco segments is required and, if so, automatically makes the adjustment.

In another embodiment of the invention, the test data from the sampling of the filter rods is displayed to the operator of the cigarette manufacturing machines so that the operator can make necessary adjustments to one or more manufacturing machines.

BRIEF DESCRIPTION OF THE DRAWING

FIG.1 shows a block diagram depicting one preferred embodiment of the method in cigarette manufacturing.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a method for automatically controlling the quality of cigarettes produced in a manufacturing process. The manufacturing process for cigarettes comprises a number of machines. Some of these machines produce components that are integrated into the final product. For example, the filter rod-forming machine forms the filter sections that are used in the tipping unit to complete the manufacture of cigarettes.

Optimally, each machine manufactures each component so that the measured value of certain quality parameters of the component falls within an acceptable range of values for that parameter. Whether by reason of improper adjustment of a machine or otherwise, from time to time, components are manufactured with values for quality parameters outside of the acceptable range. Some machines have in-line measuring devices to obtain data for certain parameters. For example, tobacco rod-forming machines frequently have the capability of measuring either the density or the weight of the tobacco segments that are manufactured.

Additionally, automatic test devices are available which can periodically sample and test either manufactured components or completed cigarette products to determine whether the measured value of certain specified parameters fall within pre-established ranges. Some of these

devices, for example Borgwaldt-KC's On Machine Inspection (OMI) device, have high throughput rates that allow for the collection of near real time test data.

FIG. 1. shows a cigarette manufacturing process utilizing a preferred embodiment of the method to automatically control the quality of cigarettes manufactured in the process. A tobacco rod-forming machine (1) with operational controls disposed to receive electronic signals from a computer (2) manufactures tobacco segments that are supplied to a tipping unit. The tobacco rod-forming machine includes in-line density measuring equipment (1A) and in-line circumference measuring equipment (1B). During the manufacturing process, tobacco rod segments are prepared and are measured to determine the density of the tobacco rod segment and the circumference of the segment. The measuring equipment communicates measured data to the computer (2) and is disposed to receive electronic signals from the computer (2) for dynamic calibration.

The tipping unit completes the manufacture of the cigarettes using filter sections provided to the tipping unit from a filter making machine (not shown) or from a supplier and using tobacco segments provided by the tobacco rod-forming (1) machine.

At regular and frequent intervals, an automatic testing and sampling device (4) extracts one or more sample filter sections from the plurality of filter sections supplied to the tipping unit (3) and tests each sample to determine the value of certain quality parameters. Preferably, the circumference of the sections at the midpoint is measured as well as the weight of the section.

Similarly, at regular and frequent intervals, the automatic testing and sampling device (4) extracts one or more completed cigarettes from the plurality of completed cigarettes prepared by the tipping unit (3) and tests each sample to determine the value of certain quality parameters related to the quality parameters of the sampled filter sections. Preferably, the weight of the

completed cigarettes, the circumference of the cigarette at the mid-point of the tobacco component and the ventilation of the completed cigarette is measured.

Preferably, the sampling of completed cigarettes is performed at a time which, given the manufacturing speed of the tipping unit, permits sampling of completed cigarettes made from the sampled sub-population of filter segments.

The automatic testing and sampling device (4) communicates the data from the testing of each sample to the computer (2). Additionally, the data can be displayed by the computer (2) to the operator on a video display terminal (6). Further, the computer can electronically communicate with the automatic testing and sampling device (4) in order to change the sampling interval or the sampling sequence.

Preferably, samples are taken from each of the sub-populations at intervals of no greater than 5 minutes. Those skilled in the art will appreciate that where the throughput of the automatic testing and sampling device (4) is inadequate to sample each of the populations at the desired frequency, a plurality of such devices can be employed.

One or more manual test devices (5A, 5B, 5C) are connected to the computer to allow operators and technicians to manually sample and test components or completed cigarettes.

After the communication of any data to the computer (2), the computer (2) evaluates the data communicated by the automatic testing and sampling device (4), the data communicated by any manual testing device (5A, 5B, 5C), the data communicated by the measuring devices of the tobacco rod-forming machine (1A, 1B) and data pre-established in its internal data files to determine, according to a first pre-established algorithm, whether and to what degree to adjust the operational controls of the tobacco rod-forming machine (1).

Alternatively, the data received or the adjustment required for the operational controls of the tobacco rod-forming machine (1) or both can be displayed to the operator on a video display terminal (6).

Further, the computer (2) evaluates the data communicated by the measuring devices of the tobacco rod-forming machine in relation to the data communicated by the automatic testing and sampling device (4) for related quality parameters. For example, where the in-line measuring device measures the density of the tobacco rod segments, the computer assesses the values measured by the in-line device with the values reported for the weight of completed cigarettes. Upon assessment of this data, the computer determines, according to a second pre-established algorithm, whether, and to what degree, re-calibration of the density measuring device (1A) of the tobacco rod-forming machine (1) is required. In like fashion, the computer assesses the values measured by the in-line circumference measuring device (1B) with the circumference data for completed cigarettes provided by the automatic testing and sampling device (4). Upon assessment of this data, the computer determines, according to a third pre-established algorithm, whether, and to what degree, re-calibration of the circumference measuring device (1B) of the tobacco rod-forming machine (1) is required.

When the computer (2) determines according to the first algorithm that an adjustment of the operational controls of one of the machines is required, it sends an electronic signal to that machine to make the required adjustment. Similarly, when the computer determines, according to the second algorithm, that re-calibration of the density measuring device (1A) of the tobacco rod-forming machine (1) is required, it sends and electronic signal to that machine to make the required recalibration. When the computer determines, according to the third algorithm, that re-

calibration of the circumference measuring device (1B) of the tobacco rod-forming machine (1) is required, it sends an electronic signal to that machine to make the required recalibration.

In a preferred embodiment of the invention, at an interval of two minutes, the automatic testing and sampling device (4) extracts a pre-determined number of filter sections (typically from five to ten) from the plurality of filter sections supplied to the tipping unit (3). The circumference of each filter section, preferably measured at the mid-point of the filter section, is measured and the filter section is weighed. Similarly, at an interval of two minutes, the automatic testing and sampling device (4) extracts a corresponding number of completed cigarettes from the plurality of completed cigarettes prepared by the tipping unit (3) and measures the circumference of the completed cigarette, preferably at the mid-point of the tobacco component of the cigarette and in any event at some point of the tobacco component, and weighs the completed cigarette. The sampling of completed cigarettes is timed so that the sampled completed cigarettes are cigarettes manufactured with filter segments from the same sub-population of filter sections which was also sampled.

Additionally, the density measuring device (1A) of the tobacco rod-forming machine (1) provides continuous data to the computer concerning the density of the tobacco segments being manufactured and the circumference measuring device (1B) of the tobacco rod-forming machine (1) provides continuous data to the computer concerning the circumference of the tobacco segments being manufactured.

The data from the measurements taken by the automatic testing and sampling device (4) is communicated to the computer (2). The computer evaluates the density of the tobacco segments used to manufacture the completed cigarettes and the weight of the completed cigarettes as well as the weight of the filter section used in the manufacture and determines,

according to a fourth pre-determined algorithm, whether dynamic recalibration of the density measuring device (1A) is required. If recalibration is required, the computer (2) sends an electronic signal to the density measuring device (1A) to recalibrate it.

The computer (2) also computes the mean of the circumferences of the sampled filter sections and the mean for the circumferences of the sampled completed cigarettes and compares the values of the two means. If the mean circumference of completed cigarettes exceeds the mean circumference of the filter sections by a specified value, the computer (2) communicates an electronic signal to the tobacco rod-forming machine (1) to decrease the circumference of the tobacco segments being produced. If the mean circumference of filter sections exceeds the mean circumference of completed cigarettes by a specified amount, the computer (2) communicates an electronic signal to the tobacco rod-forming machine (1) to increase the circumference of the tobacco segments being produced.

Additionally, the computer (2) compares the circumference data provided by the in-line circumference measuring device (1B) for the tobacco segments used to manufacture the completed cigarettes with the circumference data provided by the automatic sampling and testing device (4) for the completed cigarettes and determines, according to a fifth pre-determined algorithm, whether dynamic recalibration of the circumference measuring device (1B) is required. If recalibration is required, the computer (2) sends an electronic signal to the circumference measuring device (1B) to recalibrate it.

In a second preferred embodiment of the invention, the automatic testing and sampling device (4) extracts one filter section at 30-second intervals and measures its weight and its circumference, preferably at the mid-point of the section. Similarly, at 30 second intervals, the automatic testing and sampling device (4) extracts one completed cigarette from the plurality of

completed cigarettes prepared by the tipping unit (1) and measures the circumference of the completed cigarette, preferably at the mid-point of the tobacco component of the cigarette and in any event at a point in the tobacco component, and weighs the completed cigarette. The sampling of completed cigarettes is timed so that each sampled completed cigarette is a cigarette manufactured with from filter segments from the sub-population of filter segments also sampled.

The automatic testing and sampling device (4) communicates the data from the sampling to the computer (2). When the computer (2) has received the data from a pre-determined number of related filter sections and completed cigarettes, it computes the mean of the circumferences of the sampled filter sections and the mean for the circumferences of the sampled completed cigarettes and compares the values of the two means. If the mean circumference of completed cigarettes exceeds the mean circumference of the filter sections by a specified value, the computer (2) communicates an electronic signal to the tobacco rod-forming machine (1) to decrease the circumference of the tobacco segments being produced. If the mean circumference of filter sections exceeds the mean circumference of completed cigarettes by a specified amount, the computer (2) communicates an electronic signal to the tobacco rod-forming machine (1) to increase the circumference of the tobacco segments being produced.

The computer continues this process for each successive related sampling.

It will be appreciated by those skilled in the art that the computer (2) may also perform statistical analysis of the various measured parameters. Preferably, the computer (2) will calculate the mean and standard deviation for all measured values and the mean and standard deviation for the values measured since the last adjustment expected to impact the measured parameter. This data may be stored in the computer's internal data files and used, according to the first and second pre-established algorithms for assessments to be made by the computer (2).

It will be appreciated by those skilled in the art that the data provided to the computer (2) by the automatic sampling and testing device (4) and the manual testing devices (5A, 5B, 5C), as well as the data computed by the computer (2) according to the various pre-determined algorithms, may be graphically or numerically displayed to the operator on the video display terminal (6).

A preferred embodiment of the present invention has been disclosed. However, those skilled in the art will appreciate numerous modifications and variations from the embodiments described. It is intended that the claims herein cover those modifications and variations falling within the spirit and scope of the present invention.